

In The Claims:

1. (Currently Amended) A system for an automotive vehicle having a wheel comprising:

a first roll condition detector generating a first roll condition signal;
a second roll condition detector generating a second roll condition signal;
a third roll condition detector generating a third roll condition signal; and
a controller coupled to the first roll condition detector, the second roll condition detector and the third roll condition detector, said controller determining wheel lift in response to the first roll condition, the second roll condition and the third roll condition.

2. (Original) A system as recited in claim 1 wherein first roll condition, said second roll condition and said third roll condition are determined passively.

3. (Original) A system as recited in claim 1 wherein said controller generates a passive wheel lift status signal.

4. (Currently Amended) A system as recited in claim [[1]] 3 wherein said passive wheel lift status signal comprises a plurality of levels.

5. (Original) A system as recited in claim 1 wherein said controller generates a potential rollover signal in response to the wheel lift signal.

6. (Original) A system as recited in claim 5 further comprising a safety device, said controller controlling said safety device in response to said potential rollover signal.

7. (Currently Amended) A system as recited in claim 6 wherein said safety device comprises at least one of an active brake control system, an active rear steering system, an active front steering system, an active anti-roll bar system, and an active suspension system.

8. (Withdrawn) A method for controlling an automotive vehicle having an axle and wheels comprising:

determining a first roll condition;
determining a second roll condition;
determining a third roll condition; and

generating a wheel lift status signal in response to the first roll condition, the second roll condition and the third roll condition.

9. (Withdrawn) A method as recited in claim 8 wherein determining the first roll condition comprises:

measuring a roll rate; measuring a vehicle lateral acceleration; and
determining a relative roll angle in response to the vehicle roll rate and the vehicle lateral acceleration.

10. (Withdrawn) A method as recited in claim 9 further comprising determining a wheel departure angle in response to the vehicle roll rate and the vehicle lateral acceleration.

11. (Withdrawn) A method as recited in claim 8 wherein determining a second roll condition comprises determining a rolling radius-based wheel departure roll angle.

12. (Withdrawn) A method as recited in claim 8 wherein determining a third roll condition comprises determining a normal loading at each wheel.

13. (Withdrawn) A method as recited in claim 8 further comprising determining a fourth roll condition and wherein determining a wheel lift comprises determining a wheel lift in response to the first roll condition, the second roll condition, the third roll condition and the fourth roll condition.

14. (Withdrawn) A method as recited in claim 8 wherein determining a fourth roll condition comprises calculating an actual road torque.

15. (Withdrawn) A method as recited in claim 8 further comprising determining a fifth roll condition and wherein determining a wheel lift comprises determining a wheel lift in response to the first roll condition, the second roll condition, the third roll condition, the fourth roll condition and the fifth roll condition.

16. (Withdrawn) A method as recited in claim 15 wherein determining comprises determining a fifth roll condition comprises determining a wheel longitudinal slip.

17. (Withdrawn) A method of controlling a vehicle having a plurality of wheels comprising:

- determining a relative roll angle;
- determining a wheel departure angle;
- determining a rolling radius-based wheel departure angle;
- determining normal loading at each wheel;
- determining an actual road torque;
- determining a wheel longitudinal slip; and

determining a wheel lift status for said plurality of wheels in response to said relative roll angle, said wheel departure angle, said rolling radius-based wheel departure roll angle, the normal loading at each wheel, an actual road torque and the wheel longitudinal slip.

18. (Withdrawn) A method as recited in claim 17 wherein determining a relative roll angle comprises measuring a roll rate;

measuring a vehicle lateral acceleration; and

determining the relative roll angle in response to a vehicle roll rate and the vehicle lateral acceleration.

19. (Withdrawn) A method as recited in claim 17 wherein determining a wheel departure angle comprises:

measuring a roll rate;

measuring a vehicle lateral acceleration; and

determining the wheel departure angle in response to a vehicle roll rate and the vehicle lateral acceleration.

20. (Withdrawn) A method as recited in claim 17 wherein determining a rolling radius-based wheel departure angle comprises:

measuring a wheel speed;

determining a wheel linear velocity; and

determining the rolling radius-based wheel departure angle in response to the wheel speed and the wheel linear velocity.

21. (Withdrawn) A method as recited in claim 17 wherein determining normal loading at each wheel comprises determining a heave and non-heave load at each of the plurality of wheels.

22. (Withdrawn) A method as recited in claim 17 wherein determining an actual road torque comprises determining a driving torque, determining a braking torque and determining a wheel rotation inertia.

23. (Withdrawn) A method as recited in claim 17 wherein determining a wheel longitudinal slip comprises determining a slip power and a slip rate, and wherein determining a wheel lift status comprise determining a wheel lift status for said plurality of wheels in response to said relative roll angle, said wheel departure angle, said rolling radius-based wheel departure roll angle, the normal loading at each wheel, an actual road torque, the wheel longitudinal slip, said slip power and said slip rate.

24. (Withdrawn) A method for controlling an automotive vehicle having a plurality of wheels comprising:
determining a first wheel lift condition;
determining a second wheel lift condition;
determining a third wheel lift condition; and
generating a wheel lift flag in response to the first wheel lift condition, the second wheel lift condition and the third wheel lift condition.

25. (Withdrawn) A method as recited in claim 24 wherein generating a wheel lift flag comprises generating a wheel lift flag for each of the plurality of wheels.

26. (Withdrawn) A method as recited in claim 24 further comprising
comparing the first wheel lift condition to a first threshold;
comparing the second wheel lift condition to a second threshold;
comparing the third wheel lift condition to a third threshold;
wherein generating a wheel lift flag comprises generating a wheel lift flag is performed in response to comparing the first wheel lift condition to a first threshold, comparing the second wheel lift condition to a second threshold, and comparing the third wheel lift condition to a third threshold.

27. (Withdrawn) A method of controlling an automotive vehicle having a first wheel and a second wheel having a common axis comprising:
determining a first wheel speed;
determining a first linear corner velocity of the wheel;
determining a first rolling radius of the wheel as a function of the wheel speed and linear corner velocity; and
controlling a safety system in response to the first rolling radii.

28. (Withdrawn) A method as recited in claim 27 further comprising:
determining a longitudinal slip ratio;
comparing the slip ratio to a slip ratio threshold; and
performing determining a first rolling radius when the longitudinal slip ratio is below the slip ratio threshold.

29. (Withdrawn) A method as recited in claim 27 wherein determining a linear corner velocity comprises determining a linear corner velocity as a function of a side slip angle and a vehicle reference velocity.

30. (Withdrawn) A method as recited in claim 27 wherein determining a linear corner velocity comprises determining a linear corner velocity as a function of a steering wheel angle and a vehicle reference velocity.

31. (Withdrawn) A method as recited in claim 27 wherein determining a linear corner velocity comprises determining a linear corner velocity as a function of a side slip angle, steering wheel angle, and a vehicle reference velocity.

32. (Withdrawn) A method as recited in claim 27 further comprising determining a second rolling radii corresponding to the second wheel.

33. (Withdrawn) A method as recited in claim 32 further comprising determining a wheel departure angle as a function of the first rolling radii and the second rolling radii.

34. (Withdrawn) A method of controlling an automotive vehicle having a first wheel, a second wheel comprising:

determining a wheel speed;

determining a vehicle speed;

determining a linear corner velocity of the wheel as a function of the vehicle speed;

determining a first rolling radius of the first wheel as a function of the wheel speed and the linear corner velocity;

determining a rolling radius wheel departure angle as a function of the first rolling radius;

generating a wheel lift signal in response to the rolling radius departure angle;

and

controlling a safety system in response to the wheel lift signal.

35. (Withdrawn) A method for passively determining wheel lift of a wheel of an automotive vehicle comprising:

determining a wheel speed;

determining a linear corner velocity of the wheel;

determining a rolling radius of the wheel as a function of the wheel speed and linear corner velocity;

determining a rolling radius wheel departure angle as a function of the rolling radius; and

determining a wheel lift condition as a function of the operating input torque, the rotational speed of the wheel and the wheel response.

36. (Withdrawn) A method for controlling an automotive vehicle comprising:

determining a slip power for a wheel;

determining convergence or divergence of the slip power;

generating a wheel lift signal in response to divergence of the slip power; and

controlling a safety system in response to the wheel lift signal.

37. (Withdrawn) A method as recited in claim 36 further comprising generating a wheel grounded signal in response to convergence of the slip power.

38. (Withdrawn) A method as recited in claim 36 wherein the slip power is a function of a slip ratio.

39. (Withdrawn) A method as recited in claim 38 wherein determining a slip ratio is determined as a function of wheel speed and the vehicle velocity.

40. (Withdrawn) A method as recited in claim 39 wherein determining a slip ratio is determined as a function of wheel speed, yaw rate and the vehicle velocity.

41. (Withdrawn) A method of controlling an automotive vehicle comprising:
determining a slip ratio;
determining a slip power in response to the slip ratio;
when the slip power is positive, generating a wheel lift signal; and
controlling a safety system in response to the wheel lift signal.

42. (Withdrawn) A method as recited in claim 41 further comprising when the slip power is negative, generating a wheel grounded signal.

43. (Withdrawn) A method as recited in claim 41 further comprising controlling a safety system in response to the wheel grounded signal.

44. (Withdrawn) A method as recited in claim 41 wherein determining a slip power comprises determining the slip power in response to the slip ratio and a time derivative of the slip ratio.

45. (Withdrawn) A method as recited in claim 41 wherein determining a slip ratio is determined as a function of wheel speed and the vehicle velocity.

46. (Withdrawn) A method as recited in claim 41 wherein determining a slip ratio is determined as a function of wheel speed, yaw rate and the vehicle velocity.

47. (Withdrawn) A system for an automotive vehicle having a safety system comprising:

a plurality of wheel speed sensor generating a plurality of wheel speed signals including a first wheel speed signal;

a vehicle velocity generator generating a vehicle velocity signal; and

a controller coupled to said wheel speed sensor and the vehicle velocity generator, said controller determining a slip ratio in response to the wheel speed signal and the vehicle velocity signal, said controller determining a slip power in response to the slip ratio, when the slip power is positive, said controller generating a wheel lift signal and said controller controlling the safety system in response to the wheel lift signal.

48. (Withdrawn) A system as recited in claim 47 wherein the plurality of wheel speed signals are used to generate the vehicle velocity signal.

49. (Withdrawn) A system as recited in claim 47 further comprising a yaw rate sensor generating a yaw rate signal, said slip ratio being a function of the yaw rate signal.

50. (Withdrawn) A method for controlling an automotive vehicle comprising:
determining a slip rate for a wheel;
comparing the slip rate to a threshold;
generating a wheel lift signal in response to slip rate when the slip rate is above a threshold; and
controlling a safety system in response to the wheel lift signal.

51. (Withdrawn) A method as recited in claim 50 further comprising generating a wheel grounded signal in response to slip rate.

52. (Withdrawn) A method as recited in claim 50 wherein the slip rate is a function of a slip ratio.

53. (Withdrawn) A method as recited in claim 52 wherein determining a slip ratio is determined as a function of wheel speed and the vehicle velocity.

54. (Withdrawn) A method as recited in claim 52 wherein the slip rate is a function of the time derivative of the slip ratio.

55. (Withdrawn) A method as recited in claim 52 wherein determining a slip ratio is determined as a function of wheel speed, yaw rate and the vehicle velocity.

56. (Withdrawn) A method of controlling automotive vehicle comprising:
determining a slip rate;
generating a wheel lift signal in response to slip rate; and
controlling a safety system in response to the wheel lift signal.

57. (Withdrawn) A method as recited in claim 56 further comprising generating a wheel grounded signal in response to slip rate.

58. (Withdrawn) A method as recited in claim 57 further comprising controlling a safety system in response to the wheel grounded signal.

59. (Withdrawn) A method as recited in claim 56 wherein determining a slip rate comprises determining the slip rate in response to a velocity and a time derivative of a slip ratio.

60. (Withdrawn) A method as recited in claim 59 wherein determining a slip ratio is determined as a function of wheel speed and the vehicle velocity.

61. (Withdrawn) A method as recited in claim 59 wherein determining a slip ratio is determined as a function of wheel speed, yaw rate and the vehicle velocity.

62. (Withdrawn) A system for an automotive vehicle having a safety system comprising:

a plurality of wheel speed sensor generating a plurality of wheel speed signals including a first wheel speed signal;

a vehicle velocity generator generating a vehicle velocity signal; and

a controller coupled to said wheel speed sensor and the vehicle velocity generator, said controller determining a slip ratio in response to the wheel speed signal and the

vehicle velocity signal, said controller determining a slip rate in response to the slip ratio, when the slip rate is above a threshold, said controller generating a wheel lift signal and said controller controlling the safety system in response to the wheel lift signal.

63. (Withdrawn) A system as recited in claim 62 wherein the plurality of wheel speed signals are used to generate the vehicle velocity signal.

64. (Withdrawn) A system as recited in claim 62 wherein the plurality of wheel speed signals are used to generate a corner velocity signal, wherein the slip rate is a function of the corner velocity signal.

65. (Withdrawn) A system as recited in claim 63 further comprising a yaw rate sensor generating a yaw rate signal, said slip ratio being a function of the yaw rate signal.

66. (Withdrawn) A method of controlling an automotive vehicle comprising:
determining a heave normal load and a non-heave normal load;
determining a total normal load as a function of the heave normal load and non-heave normal load;
generating a wheel lift signal in response to the total normal load; and
controlling a safety system of an automotive vehicle in response to the wheel lift signal.

67. (Withdrawn) A method as recited in claim 66 wherein the heave normal load is a function of a vertical acceleration.

68. (Withdrawn) A method as recited in claim 66 wherein the heave normal load is a function of a roll angle.

69. (Withdrawn) A method as recited in claim 68 wherein the roll angle is a relative roll angle.

70. (Withdrawn) A method as recited in claim 68 wherein the roll angle is a function of roll rate.

71. (Withdrawn) A method as recited in claim 66 wherein the heave normal load is a function of a vertical acceleration and a relative roll angle.

72. (Withdrawn) A method as recited in claim 66 wherein the heave normal load is a function of pitch angle.

73. (Withdrawn) A method as recited in claim 72 wherein the pitch angle is a relative pitch angle.

74. (Withdrawn) A method as recited in claim 72 wherein the pitch angle is a function of a pitch rate.

75. (Withdrawn) A method as recited in claim 66 wherein the heave normal load is a function of a vertical acceleration, relative roll angle and pitch angle and a vehicle mass.

76. (Withdrawn) A method as recited in claim 66 wherein the non-heave normal load is a function of a vertical acceleration.

77. (Withdrawn) A method as recited in claim 66 wherein the non-heave normal load is a function of roll angle.

78. (Withdrawn) A method as recited in claim 77 wherein the roll angle is a relative roll angle.

79. (Withdrawn) A method as recited in claim 77 wherein the roll angle is a function of roll rate.

80. (Withdrawn) A method as recited in claim 66 wherein the non-heave normal load is a function of a vertical acceleration and relative roll angle.

81. (Withdrawn) A method as recited in claim 66 wherein the non-heave normal load is a function of pitch angle.

82. (Withdrawn) A method as recited in claim 81 wherein the pitch angle is a relative pitch angle.

83. (Withdrawn) A method as recited in claim 81 wherein the pitch angle is a function of a pitch rate.

84. (Withdrawn) A method as recited in claim 66 wherein the non-heave normal load is a function of a vertical acceleration, relative roll angle and pitch angle and a spring rate of the vehicle mass.

85. (Withdrawn) A method of controlling a vehicle having a wheel and suspension comprising:

determining a pitch angle;

determining a roll angle;

determining a vertical acceleration;

determining a normal loading due to a heave motion in response to pitch angle, roll angle, vertical acceleration and a mass of the vehicle;

determining a normal loading due to non-heave motion in response to pitch angle, roll angle, vertical acceleration and a spring rate of the suspension;

determining a total normal load as a function of the normal loading due to the heave motion and a normal load due to non-heave motion;

generating a wheel lift signal in response to the total normal load; and

controlling a safety system of an automotive vehicle in response to the wheel lift signal.

86. (Withdrawn) A method as recited in claim 85 wherein the roll angle is a relative roll angle.

87. (Withdrawn) A method as recited in claim 85 wherein the roll angle is a function of roll rate.

88. (Withdrawn) A method as recited in claim 85 wherein the pitch angle is a relative pitch angle.

89. (Withdrawn) A method as recited in claim 85 wherein the pitch angle is a function of a pitch rate.

90. (Withdrawn) A system for controlling an automotive vehicle having a wheel, a suspension and a safety system comprising:

a pitch rate sensor generating a pitch rate signal;

a vertical acceleration sensor;

a roll rate sensor generating a roll rate signal; and

a controller coupled to the vertical acceleration sensor, the roll rate sensor and the pitch rate sensor, said controller determining a roll angle from the roll rate signal and a pitch angle from the pitch angle signal, said controller determining normal loading due to a heave motion in response to pitch angle, roll angle, vertical acceleration and a mass of the vehicle, said controller determining a normal loading due to non-heave motion in response to pitch angle, roll angle, vertical acceleration and a spring rate of the suspension, said controller determining a total normal load as a function of the normal loading due to the heave motion and a normal load due to non-heave motion, said controller generating a wheel lift signal in response to the total normal load, and said controller controlling the safety system of an automotive vehicle in response to the wheel lift signal.

91. (Withdrawn) A system as recited in claim 90 wherein the roll angle is a relative roll angle.

92. (Withdrawn) A system as recited in claim 90 wherein the pitch angle is a relative pitch angle.

93. (Withdrawn) A method of controlling an automotive vehicle having a wheel comprising:

determining an actual road torque applied to the wheel;

determining a calculated road torque; and

generating a wheel lift signal in response to the calculated road torque and the actual road torque.

94. (Withdrawn) A method as recited in claim 93 wherein determining an actual road torque comprises determining an actual road torque as a function of wheel acceleration.

95. (Withdrawn) A method as recited in claim 93 wherein determining an actual road torque comprises determining an actual road torque as a function of wheel acceleration and driving torque.

96. (Withdrawn) A method as recited in claim 93 wherein determining an actual road torque comprises determining an actual road torque as a function of wheel acceleration and braking torque.

97. (Withdrawn) A method as recited in claim 93 wherein determining an actual road torque comprises determining an actual road torque as a function of wheel acceleration, driving torque and braking torque.

98. (Withdrawn) A method as recited in claim 93 wherein determining a calculated road torque comprises determining a calculated road torque in response to normal loading.

99. (Withdrawn) A method as recited in claim 93 wherein determining a calculated road torque in response to normal loading comprises determining a heave normal load and a non-heave normal load, and determining a total normal load as a function of the heave normal load and non-heave normal load.

100. (Withdrawn) A method as recited in claim 93 wherein determining a calculated road torque comprises determining a calculated road torque in response to normal loading and longitudinal wheel slip.

101. (Withdrawn) A method of controlling an automotive vehicle comprising:
determining a braking torque;
determining a driving torque;
determining a wheel acceleration;

determining an actual road torque as a function of wheel acceleration, driving torque and braking torque;
determining a total normal load;
determining a calculated road torque in response to the total normal load;
comparing the actual road torque and the calculated road torque;
when the actual road torque is less than the calculated road torque, generating a wheel lift signal; and
controlling a safety device in response to the wheel lift signal.

102. (Withdrawn) A method as recited in claim 101 wherein determining a total normal load comprises determining a heave normal load and a non-heave normal load, and determining a total normal load as a function of the heave normal load and non-heave normal load.

103. (Withdrawn) A method as recited in claim 101 wherein determining a total normal load as a function of the heave normal load and non-heave normal load comprises determining a heave load in response to pitch angle, roll angle, vertical acceleration and a mass of the vehicle.

104. (Withdrawn) A method as recited in claim 101 wherein determining a total normal load as a function of the heave normal load and non-heave normal load comprises determining a non-heave load as a function of pitch angle, roll angle, vertical acceleration and a spring rate of a suspension.

105. (Withdrawn) A method as recited in claim 101 wherein determining a calculated road torque comprises determining a calculated road torque in response to normal loading a longitudinal wheel slip.

106. (Withdrawn) A method for controlling an automotive vehicle having a plurality of wheels comprising:

measuring a yaw rate;
determining a lateral acceleration;
determining a roll rate;
determining longitudinal acceleration;

generating wheel lift signal as a function of yaw rate, lateral acceleration, roll rate and longitudinal acceleration; and

controlling a safety system in response to the wheel lift signal.

107. (Withdrawn) A method as recited in claim 106 further comprising determining a pitch acceleration and, wherein determining wheel lift comprises determining wheel lift as a function of yaw rate, lateral acceleration, roll rate, longitudinal acceleration and pitch acceleration.

108. (Withdrawn) A method as recited in claim 106 further comprising controlling the safety system to counteract wheel lift.